What we claim is,

1. An on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode comprising:

a p-GaAs single crystal substrate having a top surface and a bottom surface;

a p-$(ZnSe/ZnTe)^m$ (m: integer denoting a number of pair layers) superlattice which is made by piling p-ZnSe thin films and p-ZnTe thin films reciprocally for changing bandgaps stepwise and is epitaxially grown directly on the top surface of the p-GaAs substrate;

a p-$Zn_{1-x}Mg_xS_ySe_{1-y}$ ($0 \leqq x \leqq 0.8$, $0 \leqq y \leqq 0.8$) layer epitaxially grown on the p-$(ZnSe/ZnTe)^m$ superlattice or via a p-ZnSe buffer layer upon the p-$(ZnSe/ZnTe)^m$ superlattice;

an i-$Zn_{1-x}Mg_xS_ySe_{1-y}$ ($0 \leqq x \leqq 0.8$, $0 \leqq y \leqq 0.8$) layer epitaxially grown on the p-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer;

an n-$Zn_{1-x}Mg_xS_ySe_{1-y}$ ($0 \leqq x \leqq 0.8$, $0 \leqq y \leqq 0.8$) layer epitaxially grown on the i-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer;

a metallic n-electrode which is formed upon a part of the n-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer and has a top aperture for allowing incidence light to enter; and

a metallic p-electrode formed on the bottom surface of the p-GaAs substrate.

2. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode according to claim 1, wherein a p-ZnSe buffer layer is interposed between the p-$(ZnSe/ZnTe)^m$ superlattice and the p-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer.

3. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode according to claim 2, wherein the i-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer has an impurity concentration less than $10^{16}cm^{-3}$.

4. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode according to claim 1, wherein the n-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer has a bandgap En which is equal to or higher than a bandgap Ei of the i-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer ($En \geqq Ei$).

5. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode according to claim 4, wherein the i-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer is an i-ZnS_ySe_{1-y} layer including no Mg (x=0) and the n-

$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer is either an n-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer including Mg ($x \neq 0$) or an n-ZnS_ySe_{1-y} layer including no Mg (x=0).

6. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode according to claim 4, wherein the i-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer is an i-ZnSe layer including neither Mg nor S (x=0, y=0) and the n-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer is either an n-ZnS_ySe_{1-y} layer including no Mg ($x=0$, $y \neq 0$) or an n-ZnSe layer including neither Mg nor S (x=0, y=0).

7. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode according to claim 1, wherein the top aperture on the n-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer which receives incidence light is coated with a mask made of Al_2O_3, SiO_2, TiO_2, La_2O_3 or MgF_2 for antireflection and protection.

8. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode according to claim 1, wherein external quantum efficiency is more than 30 % for light wavelengths between 300nm and 450nm.

9. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode according to claim 1, wherein external quantum efficiency is more than 40 % for a light wavelength of 400nm.

10. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ pin photodiode according to claim 1, wherein a dark current is less than 10^{-9} A/cm^2 under a reverse bias between 0 V and -20 V.

11. An on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode for inducing avalanche amplification by a strong electric field formed by applying a reverse bias below a breakdown voltage, comprising:

a p-GaAs single crystal substrate having a top surface and a bottom surface;

a p-$(ZnSe/ZnTe)^m$ (m: integer denoting a number of pair layers) superlattice which is made by piling p-ZnSe thin films and p-ZnTe thin films reciprocally for changing bandgaps stepwise and is epitaxially grown on the top surface of the p-GaAs substrate;

a p-$Zn_{1-x}Mg_xS_ySe_{1-y}$ ($0 \leqq x \leqq 0.8$, $0 \leqq y \leqq 0.8$) layer epitaxially grown on the p-

$(ZnSe/ZnTe)^m$ superlattice or via a p-ZnSe buffer layer upon the p-$(ZnSe/ZnTe)^m$ superlattice;

a lower-doped n^--$Zn_{1-x}Mg_xS_ySe_{1-y}$ ($0 \leqq x \leqq 0.8$, $0 \leqq y \leqq 0.8$) layer epitaxially grown on the p-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer;

a higher-doped n^+-$Zn_{1-x}Mg_xS_ySe_{1-y}$ ($0 \leqq x \leqq 0.8$, $0 \leqq y \leqq 0.8$) layer epitaxially grown on the lower-doped n^--$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer;

a metallic n-electrode which is formed upon a part of the higher-doped n^+-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer and has a top aperture for allowing incidence light to enter; and

a metallic p-electrode formed on the bottom surface of the p-GaAs substrate.

12. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode according to claim 11, wherein a p-ZnSe buffer layer is interposed between the p-$(ZnSe/ZnTe)^m$ superlattice and the p-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer.

13. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode according to claim 11, wherein an i-$Zn_{1-x}Mg_xS_ySe_{1-y}$ ($0 \leqq x \leqq 0.8$, $0 \leqq y \leqq 0.8$) layer is interposed between the p-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer and the n^--$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer.

14. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode according to claim 11, wherein the n^+-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer has a bandgap En^+ which is equal to or higher than a bandgap En^- of the n^--$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer ($En^+ \geqq En^-$).

15. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode according to claim 14, wherein the n^--$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer is an n^--ZnS_ySe_{1-y} layer including no Mg (x=0) and the n^+-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer is either an n^+-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer including Mg ($x \neq 0$) or an n^+-ZnS_ySe_{1-y} layer including no Mg (x=0).

16. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode according to claim 14, wherein the n^--$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer is an n^--ZnSe layer including neither Mg nor S (x=0, y=0) and the n^+-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer is either an n^+-ZnS_ySe_{1-y} layer including no Mg (x=0, $y \neq 0$) or an n^+-ZnSe layer including neither Mg nor S (x=0, y=0).

17. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode according to claim 11, wherein the top aperture on the n^+-$Zn_{1-x}Mg_xS_ySe_{1-y}$ layer which receives incidence light is coated with a mask made of Al_2O_3, SiO_2, TiO_2, La_2O_3 or MgF_2 for antireflection and protection.

18. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode according to claim 11, wherein external quantum efficiency is more than 100 % for light wavelengths between 300nm and 450nm.

19. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode according to claim 11, wherein external quantum efficiency is more than 200 % for a light wavelength of 400nm.

20. The on-p-GaAs substrate $Zn_{1-x}Mg_xS_ySe_{1-y}$ avalanche photodiode according to claim 11, wherein external quantum efficiency is enhanced by a spin-orbit interaction at a wavelength of 395nm and sensitivity is nearly flat from 350nm to 430nm.